

# **DEVELOPMENT AND ANALYSIS OF RESPONSE PROPERTIES FOR SIMPLE CELLS IN PRIMARY VISUAL CORTEX**

**By**

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Department of Electrical Engineering

*Submitted  
in fulfillment of the requirements  
for the degree of*

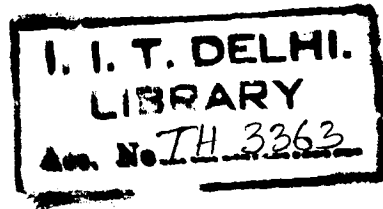
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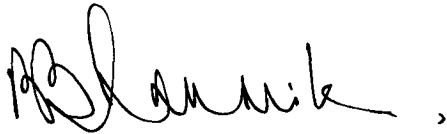
**August, 2005**



*Dedicated to my parents..... ....*

## CERTIFICATE

This is to certify that the thesis entitled "Development and analysis of response properties for simple cells in primary visual cortex", being submitted by Mr. Akhil Ranjan Garg for the award of the degree of Doctor of Philosophy in the Department of Electrical Engineering, the Indian Institute of Technology, Delhi is a record of bonafide research work done by him under my supervision and guidance. The matter embodied in this thesis has not been submitted to any other Institute or University for the award of any other degree or diploma.



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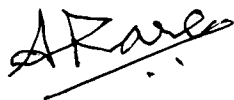
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A handwritten signature in black ink, appearing to read "A. K. Rave", with a horizontal line underneath it.



# Abstract

The thesis can be broadly divided into three major parts; in the first part we have presented a model for the development of simple cell's receptive field structure. The center piece of this model is that it is based on the recent experimental studies of hetero-synaptic interactions in various systems that have shown the role of spatial signaling in the plasticity, challenging the conventional understanding of Hebb's rule. In addition to such hetero-synaptic interactions the model uses activity and synaptic efficacy dependent competition among axons for limited amount of a common resource. The connectivity pattern so developed between LGN and cortical neuron resembles the experimental observed RF structures of simple cell i.e. it has elongated segregated ON/OFF regions.

Recent studies in cat and ferret report the existence of untuned inhibitory neurons in layer 4. The existence of such untuned inhibition has also been reported in monkeys also. In the next part of the thesis we explore the role of such inhibition in balancing feed-forward excitation and in modulating the response of the cortical cell. We have determined various regimes of such balanced condition so as to make the response of cortical cell sharply tuned and contrast invariant. Our study support the findings that cerebral cortex operates through such balance of excitation and inhibition.

In the last part of the thesis we have presented a model based on competition for limited amount of neurotrophin present during development and diffusive cooperation among nearby cortical and same type of LGN cells for the formation of spatio-temporal receptive field of simple cells. We also studied the contribution of untuned inhibition in sharpening the direction selectivity of the cortical cell. We find that using such an inhibition substantially improves the direction selectivity of the cortical cell.



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